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MARKET-BASED LAND REFORM AND FARM EFFICIENCY IN COLOMBIA: A DEA APPROACH

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Abstract

This paper uses Data Envelopment Analysis to measure scale and technical efficiencies of 925 farms in rural Colombia and a Tobit model to identify the effects of land market characteristics on efficiency. Findings indicate that although larger farms are more scale efficient, they are not more technical efficient than small farms. Participation in land markets increases technical efficiency, indicating a positive potential role for market-based land reform. Further results show that intensity of violence in rural areas results in increased scale efficiency, allegedly through consolidation of land ownership.

Key words: DEA, farm efficiency, Colombia, land reform

JEL codes: Q15, O13, O54, D24

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1. INTRODUCTION

Land is the main factor of production in rural areas of the developing world. Social status and power relations are mostly determined by the structure of landholdings, and the inegalitarian distribution of land is often the origin of social unrest when large portions of the rural population struggle for access to land.

Traditionally, land reforms were based on controlled redistribution of expropriated or frontier lands with the aim of reducing ownership concentration, but without much regard to production efficiency. Since the 1990s, new land reform programs in many developing countries are increasingly looking towards land markets as the mean of redistributing land while raising productive efficiency in part due to pressure from external donors such as the World Bank.

Empirical studies have found an inverse relationship between farm size and land productivity in developing countries, suggesting that land markets should lead to a relatively egalitarian structure as land is transferred from large to small and more efficient farmers (Binswanger *et al*., 1993; van Zyl, *et al*., 1995; Bardhan, 1973; Barnum and Squire, 1978; Carter, 1984). However, more often than not, land sales go in the opposite direction as land is transferred from distressed small farmers to large landlords and moneylenders. Although there may exist some real economies of scale, they are mostly temporary and the result of policies that favor larger farmers over small ones (van Zyl, *et al*., 1995). The ongoing concentration of land ownership can only mean that large farms are relatively more efficient than small ones or, more likely, that concentration is due to distortions in land and related factor markets.

Many of the market distortions are due to government intervention in the output market that drives up the price of land and undermines both efficiency and equity. Imperfections in other factor markets may also hamper efficiency and equity. For example, credit constraints or lack of insurance mechanisms reduce the ability of small farmers to buy additional land, although they may be more efficient, and increase their dependency of land sales in times of crisis (Bardham and Udry, 1999; Binswanger, *et al*., 1995).

At present, there is a controversy between market and non-market mechanisms to influence land redistribution. In the presence of market distortions, studies that embrace non-market mechanisms point out that the activation of land sales is likely to cause increased land concentration at the expense of poorer farmers while hampering efficiency (Baland et al, 2002; Zimmerman and Carter, 1997; Collier, 1983). Neoliberal land reform policies that are based on market allocation downplay market failures and rely on the capacity of land markets, particularly rental markets, to lead to efficiency. Studies that embrace market mechanisms point out that rental markets are less affected by credit constraints and have lower transaction costs than sales markets, thus further contributing to both efficiency and equity measures (Deininger 2001, Kingsmill and Rogg, 2000; Carter and Olinto, 1996). However, as pointed out by Balland et al (2002), the impact of land sales on efficiency and land distribution is an empirical matter and cannot be determined a priori.

Colombia provides an interesting and useful case study to analyze the impact of market-based land reforms. The country has a long history of land reform policies. Since the 1930s, there have been numerous attempts to reduce the highly unequal distribution of land in order to reduce rural poverty and increase agricultural productivity through redistributive land reforms. A World Bank mission identified maldistribution of productive resources, especially land, as one of the root causes of economic stagnation in the 1950s. Despite massive efforts, Colombia still presents a highly dualistic distribution of land, with a large number of small farms and a small number of very large farms that account for a large share of the total productive land. The complexity of rural markets and prevalence of violence have to be considered in the design of policies. Violence and insecurity in Colombia are important factors that cannot be ignored when analyzing rural land markets as they are in part rooted in the unequal and exclusionary agrarian system.

This paper uses Data Envelopment Analysis to measure the efficiency of a sample of farms in Colombia and a Tobit model to explain the sources of efficiency. The results shed light on the farm size-efficiency argument and the likelihood of success of alleged efficiency and equity effects of market-based land reforms. The paper is structured as follows. Section 2 describes the functioning of land markets in Colombia and the recent history of the agrarian reform. Section 3 describes the survey methodology and other sources of data used for the analysis. Section 3 presents the methodological approach used in our study to calculate the efficiency indexes and to analyze the sources of inefficiency. In section 4 we provided the summary and conclusions of the efficiency analysis.

2. BACKGROUND OF THE PROBLEM

Agricultural development in Colombia has involved substantial misallocation of resources. Land reform was concentrated on the colonization and titling of frontier lands rather than on the redistribution of land toward small farmers. These policies did not reduce poverty in the rural areas and limited the access of poor farmers to good land that was occupied by low-intensity livestock ranching. Heath and Binswagner (1996) point out that there is a "large-farmer bias" in Colombia, where livestock and grain crops have been the most protected sectors, neither of which is labor intensive, favoring the creation of large states. Also, credit policies tended to discriminate against small farmers that had very limited access to formal sources of credit. This situation has increased the propensity of violence in rural areas creating insecurity and reducing the incentive to invest. Land investment during the 1970s was concentrated on activities that were relatively low intensive in the use of labor, like livestock and grain crops.

Most authors conclude that land ownership is a major element explaining the country's violent history (Kay, 2001; Kirchoff and Ibañez, 2001; Grusczynski and Jaramillo, 2002). Conflict over land is one of the main causes of rural population displacement in Colombia now reaching over 1.2 million people displaced. Poor rural populations are the most affected by this situation. They are caught in the middle of four key political actors in the conflict: the State, the paramilitary, the guerrillas, and the drug mafia. Therefore, the performance of the new land reform is likely to be importantly shaped by the geography and severity of violence.

Land ownership patterns in Colombia have evolved over time. During the 1984–97 period there was a clear tendency of increasing concentration of landownership. As illustrated in Table 1, this period was characterized by a marked concentration of land in the hands of large farms, largely at the cost of medium-sized farms. While the number of "small" farm units (comprising less than two *Unidades Agrícolas Familiares* [UAFs][1]) increased slightly, from 89.9 percent to 91.1 percent of all farms, the share of area cultivated by these shows a slight decrease, from 23.1 percent in 1984 to 21.4 percent in 1997. A more significant reduction in area, from 30.5 percent to 24.8 percent with almost constant share in the farm units, is observed for medium-sized farms. This implies that large farms, even though their number slightly decreased, increased their share of area from 46.3 percent to 53.8 percent over the period. The lower panel of Table 1 illustrates that conclusions are even more pronounced if physical area is taken as the basis for the assessment.

One important factor perpetuating this dual property system is the segmentation of land markets. A 1994 study by the Food Agricultural Organization (FAO), reveals that land markets in Colombia are a reflection of the structure of landownership. Land markets are quite active but are not able to transfer land from large producers to small or landless farmers. There are two types of market segmentation. The first type is economic. Sales of large and smallholdings are done in separate markets. Normally there is not connection between these two markets, with the exception of areas affected by violence, where small farmers migrate and had to sell their land, favoring the concentration of land. The second type of segmentation is social. Land is many times transferred to neighbors, family, or other related people in order to protect the community. In both cases buyers and sellers have the same socioeconomic level. Rental markets are also segmented, but to a lesser degree than sales markets.

3. METHODOLOGY

To determine the relative impact that land markets and institutional distribution of land have on productive efficiency a two-step procedure will be used. First, farm technical efficiency is computed using linear programming techniques, which is then used as the dependent variable in a second stage regression, where the explanatory variables measure land markets characteristics relevant to the farmers.

In the first stage a non-parametric frontier analysis method, also known as Data Envelopment Analysis (DEA), is used to estimate the household level of agricultural efficiency. One important advantage of DEA model is that it does not require specifying an explicit functional form for technology (Desli, 1999; Bauer, 1990). The DEA imposes the simple restriction that all farms lie on or below the efficient frontier (Papadas and Dahl, 1991; Thiele and Brodersen, 1999; Manthijs and Swinnen, 2001).

The DEA methodology uses linear programming techniques to measure efficiency as the distance of each farm from a non-parametric production frontier (Gilligan, 1998). Each observation is characterized by an input vector $X=(x_1, x_2, \ldots, x_m)$ and an output vector $Y=(y_1, y_2, \ldots, y_s)$ Feasible input-output combinations are represented by the production possibility set, T, given by:

$$T=\left\{(X,Y)\middle| Y\geq 0 \text{ can be produced from X}\right\}$$

Farrell (1957) defined technical efficiency via an isoquant that contains the efficient points using the minimum required inputs to produce a unit level of output. For a given input-output vector, the efficiency frontier is expressed in terms of minimizing the input requirements per unit of output. In figure 1 the frontier isoquant is derived by the linear combination of the efficient farms (B and C). Total technical efficiency of farm A is measured by the ratio E_A^T= OD/OA, where OD represents the lowest input combination which farm A could use to produce a unit of output.

Consider a sample of n farms (k=1,...,n), producing s outputs (i=1,...,s) with m inputs (j=1,...,m). Based on Farrell's ideas, Charnes, Cooper, and Rodhes (1978) proposed the following linear programming model to measure technical efficiency under the assumption of constant returns to scale (CRS):

$$
\begin{aligned}
& \min_{\{\lambda_k, \theta_1, \ldots, \theta_n\}} \lambda_k \\
& s.t \\
& \begin{bmatrix} y_{1,1} & \cdots & y_{1,n} \\ \cdots & \cdots & \cdots \\ y_{s,1} & \cdots & y_{s,n} \end{bmatrix} \begin{bmatrix} \theta_1^k \\ \cdots \\ \theta_n^k \end{bmatrix} \geq \begin{bmatrix} y_1^k \\ \cdots \\ y_s^k \end{bmatrix} \\
& \begin{bmatrix} x_{1,1} & \cdots & x_{1,n} \\ \cdots & \cdots & \cdots \\ x_{m,1} & \cdots & x_{m,n} \end{bmatrix} \begin{bmatrix} \theta_1^k \\ \cdots \\ \theta_n^k \end{bmatrix} \leq \lambda_k \begin{bmatrix} x_1^k \\ \cdots \\ x_s^k \end{bmatrix} \\
& \Theta \geq 0
\end{aligned}
\tag{1}
$$

where λ_k is the Farell's measure of total efficiency (E_k^T) of the k^{th} farm and satisfies $0 \leq \lambda_k \leq 1$. When $\lambda_k = 1$, the farm is operating on the frontier. If $\lambda_k < 1$ the farm does not operate on the frontier and is inefficient. The vector $\Theta_{(1 \times n)}$ contains weights attached to each farm. The vectors X^k and Y^k denote inputs and outputs of the k^{th} farm. Similarly, Y and X are the matrices of all outputs and inputs. The constraints in (1) indicate that the weighted combination of other farms must produce at least as much of each output, as does the k^{th} farm (first constraint), while not using any more of any input than does farm k (second constraint).

Banker et al. (1984) modified the above model to allow for variable returns to scale (VRS) by adding the constraint $\sum_{j=1}^{n} \theta_j = 1$. Introducing this constraint has the effect of pulling the frontier in to envelop the observations more closely. Total efficiency of the farms can be decomposed into two effects, a pure technical effect (E^P), and a scale effect (E^S) which depends on whether farms are appropriately sized or not (Piesse, et al., 1996). The pure technical effect (E^P) is obtained by solving the optimization problem with the new constraint. The measure of scale efficiency (E^S) can be derived by taking the ratio of the constant returns to the variable returns efficiency index, $E^S = E^T/E^P$. Figure 2 illustrates intuitively the efficiency measures. Constant returns to scale technology is denoted by the linear production curve OP. Farms A, D, and E, are overall technically inefficient because they are below the CRS frontier. Allowing for VRS the frontier is concave and farms A and D become pure technically efficient ($E_A{}^P = E_D{}^P = 1$). The effect that remains is the scale effect. Farm A is scale inefficient by $E_A{}^S = OX^2/OX$ because it is too small. Similarly, farm D is pure technically efficient but scale inefficient because it is too large. Farm E is technically inefficient by $E_E{}^P = OX^3/OX^2$ and scale inefficient by $E_E{}^S = OX^2/OX^1$, yielding a total level of inefficiency relative to the CRS frontier of $E_E{}^T = OX^3/OX^1$.

In the second stage, parametric techniques are used to regress the efficiency indexes on a set of land market characteristics pertinent to each farmer generating the following model:

$$E_k = W_k \beta + e_k \tag{2}$$

where $E_k = \left\{ E^T, E^P, E^S \right\}$, W_k is a vector of explanatory variables, β is the parameter to be estimated, and e_k is the error term. The set of explanatory variables includes variables such as the amount of operated land, a dummy representing whether or not the household is a land reform beneficiary, a dummy indicating participation in the rental markets, and an index indicating the level of conflict in the area where the farm is located.

4. DATA SOURCES

The data used are two main sources. One is a survey undertaken by the Departamento Nacional de Plantación (DNP) in collaboration with the Instituto Interamericano de Cooperación para la Agricultura (IICA) and the World Bank. The data were collected in 1999 and contain information on the period comprised between July 1998 and June 1999.

The survey consists of two separate modules: Module 1 was implemented at the Agricultural Productive Unit (UPA)[2]. Information in this module is related to all agricultural and livestock activities in which the UPA is involved, as well as information regarding rental or sales activity, land quality, credit, permanent and temporary labor, farm assets, and technical assistance. Thus, it contains agricultural information. Module 2 was implemented at the agricultural producer's household level and contains non-agricultural information. This module collected information on basic household characteristics (composition, education, income, expenses, etc.), off-farm labor, migration, non-farm assets, and non-farm family business.

The sample includes 55 municipalities that were stratified into 11 zones[3] of similar agro-ecological characteristics and systems of production. The data were collected for about 1600 UPAs using a 3-stage stratified random procedure for the areas[4]. After elimination of incomplete observations the sample is reduced to 925 production units.

The second source is data on displaced people used to assess the impact of violence on farm efficiency. The available literature does not offer a universally accepted measure of violence. Kirchhoff and Ibañez (2001) argue that violence and the perception of insecurity are the main reasons motivating displacement in Colombia. Thus, the number of displaced people can be considered a good indicator of the level of conflict in the expulsory location. This data is provided by the International Committee of the Red Cross and contains detailed information on the number of displaced population that can easily match the levels of aggregation in the survey.

The analysis is conducted at the regional level with the area being divided into eleven agricultural regions. This is motivated by the agro-climatic characteristics that remain constant within the region but vary across regions. In this context one can assume that the production technology is constant for farmers in the same agro-climatic zone but potentially different across zones.

Data used in the non-parametric efficiency analysis of Colombian farms include two categories of outputs: (1) crops; and (2) livestock. Inputs are classified into six broad categories: (1) hired labor (2) family labor; (3) crop inputs (seeds, fertilizers, and other chemicals); (4) animal inputs (purchased feed, breeding and other expenses); (5) machinery; and (6) land. The outputs and inputs included in the analysis are valued at their opportunity costs.

5. RESULTS AND DISCUSSION

5.1 DEA Results

This section presents the indexes of pure, scale and total efficiencies calculated for each agro-climatic region. Thus, a benchmark frontier is establish in each region for the technically efficient farms in order to measure the inefficiency of the other farms compared to those lying on the frontier.

Table 2 presents the DEA results 11 agro-climatic zones analyzed. The mean index of total efficiency with respect to best practice farms ranges form 42% in Veriente Sur to 68% in Valle del Cesar. Since in this analysis the size effect is of particular interest, greater attention is paid to the scale efficiency effects. In Data Envelopment Analysis extreme values and data variance play a more important role than in parametric analysis. Particularly, scale efficiency is sensitive to the variation in farm size.

The region of Magdalena Alto and Veriente Sur present the lowest index for scale efficiency. For Magdalena Alto, the average land area for the farms on the efficiency frontier is approximately 148 ha, but the average farm size for the entire region is only 64ha. This clearly indicates that a source of scale inefficiency in Magdalena Alto is the fact that farms are too small. Small farmers are scale inefficient relative to the larger units. Thus, increasing the size of the smallest farms will help to foster overall efficiency.

In comparison, Vertiente Nororiental and Piedemonte Llanero have larger values of scale efficiency indexes, in part due to the lower variance in farm size within these two regions compare to Magdalena Alto. For example the benchmark frontier for Vertiente Nororiental is composed of small farms whose size ranges from 1 to 51 ha.

5.2 Tobit Results

The Tobit results for all 925 farms in the sample are presented in Table 3. The empirical results indicate that farmers participating in land markets attain a higher level of scale efficiency. By renting or buying farmland, this group is better able to adjust the size of their operation closer to the optimal size. However, in terms of pure efficiency, this group is not different than non-participants. Overall, land renters are more technically efficient than other groups, although overall the technical efficiency of those buying land, in the end, does not appear to be different than the overall technical efficiency of those who do not buy land.

The Tobit results also point out that recent land reform beneficiaries were less scale and technically efficient. Thus, administrated land reform through INCORA was shown to be less efficient than market-driven land allocation. One stated goal of INCORA is to benefit small farmers. However, land distributed this way may not be enough for these farmers to attain full-scale efficiency.

On the other hand, controlling for the forms of land acquisition (market or land reform), larger farms are more scale efficient but less technically efficient. In fact, the results show that the technical benefits of their size are outweighed by their technical inefficiency. The implications for implementing land reform with a large population of small farmers is that these farmers need to increase their size to increase their scale efficiency. This need can complement a market-based land reform to increase overall efficiency.

Further results show that the intensity of violence at the municipal level, as measured by the percentage of the population displaced, results in scale efficiency. As small farmers are more likely to be displaced, violence induces consolidation of land ownership resulting in scale efficiency. However, other types of efficiency are not affected by violence.

6. CONCLUDING REMARKS

A main conclusion from the Colombia experience is that a market-based land reform system is likely to be more technically efficient than an administrative one. Much of the efficiency advantage, however, is driven by scale efficiency and not due to pure technical efficiency. Although larger farms are more scale efficient, smaller farms are more technically efficient. Given the large farm population comprised by small farmers in Colombia, a worthwhile development strategy is to strengthen land markets, particularly rental markets, to overcome barriers that hamper the functioning of land markets.

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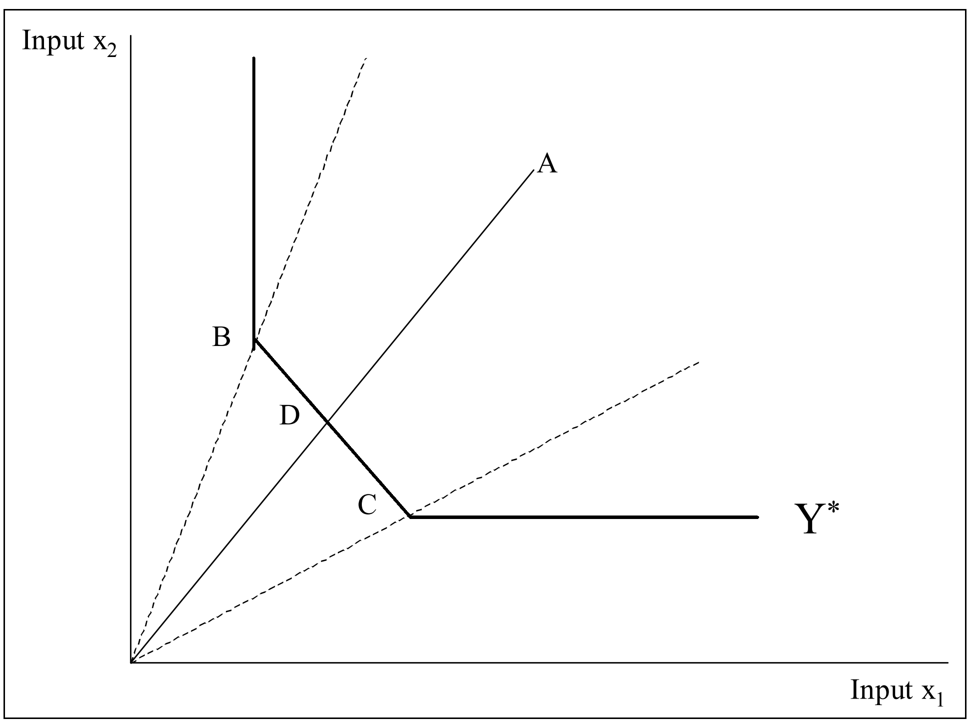
Table 1. Structure of landownership and land use in Colombia, between 1984 and 1997

	By Productive Capacity			
	Area		% of farms	
	1984	**1997**	**1984**	**1997**
Small (0–2 UAF)	23.15	21.40	89.92	91.11
Medium (2–10 UAF)	30.50	24.80	8.68	7.81
Large (> 10 UAF)	46.35	53.80	1.40	1.08
	By Physical Extension			
	Area		**% of farms**	
	1984	**1997**	**1984**	**1997**
< 100 hectares	40.00	34.50	96.90	97.40
100–500 hectares	27.50	20.50	2.70	2.30
>500 hectares	32.50	45.00	0.40	0.30

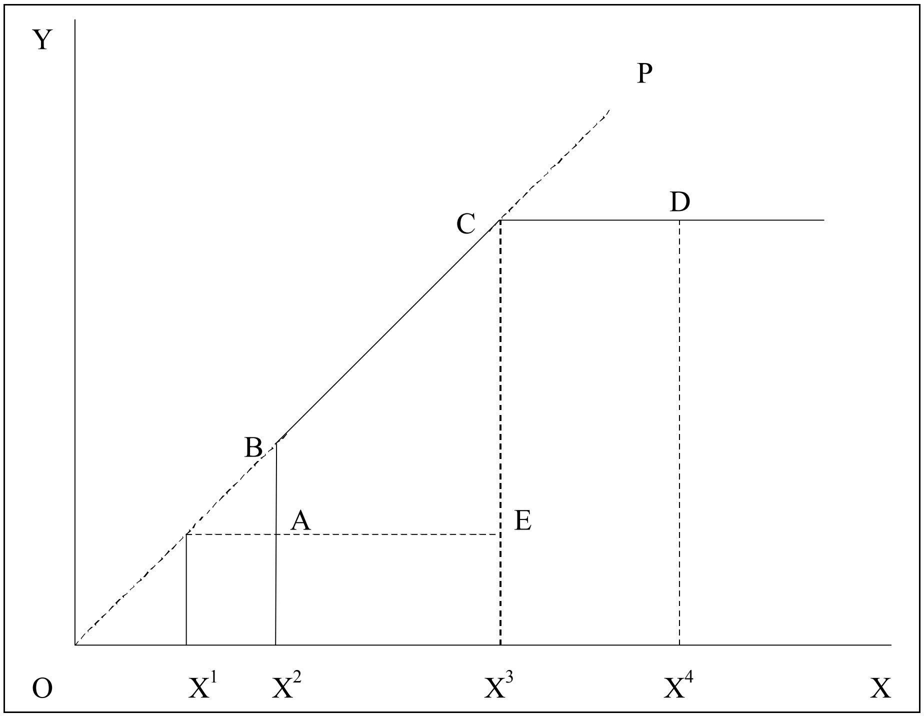
Sources: Top panel from Machado (1999); bottom panel from Mondragon (1999).

Figure 1: Farrell efficiency measurement



Source: van Zyl, Binswanger, and Thirtle (1995)

Figure 2: Decomposition of technical efficiency and scale efficiency



Source: van Zyl, Binswanger, and Thirtle (1995)

Table 2. Total, Pure and Scale Efficiency Indexes

		Total Efficiency	Pure Efficiency	Scale Efficiency
Valle del Sinú and San Jorge	mean	0.56	0.75	0.69
	median	0.46	0.98	0.90
	S. Deviation	0.39	0.30	0.37
	# of efficient firms	26.00	38.00	28.00
	% of efficient firms	0.33	0.48	0.35
Valles del Bajo Magdalena	mean	0.54	0.67	0.72
	median	0.56	0.83	0.89
	S. Deviation	0.39	0.36	0.34
	# of efficient firms	26.00	41.00	28.00
	% of efficient firms	0.28	0.44	0.30
Valles del Cesar and Ranchería	mean	0.68	0.80	0.81
	median	0.82	1.00	0.98
	S. Deviation	0.35	0.29	0.28
	# of efficient firms	33.00	44.00	36.00
	% of efficient firms	0.41	0.55	0.45
Magdalena Medio	mean	0.61	0.77	0.74
	median	0.81	1.00	0.98
	S. Deviation	0.41	0.33	0.34
	# of efficient firms	30.00	41.00	32.00
	% of efficient firms	0.43	0.59	0.46
Magdalena Alto	mean	0.45	0.62	0.65
	median	0.39	0.62	0.78
	S. Deviation	0.37	0.35	0.34
	# of efficient firms	21.00	36.00	23.00
	% of efficient firms	0.19	0.32	0.21
Vertiente Nororiental	mean	0.65	0.83	0.76
	median	0.92	1.00	0.99
	S. Deviation	0.39	0.30	0.32
	# of efficient firms	32.00	45.00	32.00
	% of efficient firms	0.47	0.66	0.47
Altiplanos	mean	0.59	0.78	0.74
	median	0.59	0.98	0.82
	S. Deviation	0.35	0.30	0.29
	# of efficient firms	23.00	37.00	26.00
	% of efficient firms	0.31	0.49	0.35
Vertiente Central	mean	0.58	0.72	0.74
	median	0.59	0.88	0.91
	S. Deviation	0.39	0.32	0.31
	# of efficient firms	33.00	39.00	34.00
	% of efficient firms	0.36	0.42	0.37

Table 2. Total, Pure and Scale Efficiency Indexes (Cont.)

Vertiente Sur	mean	0.42	0.60	0.68
	median	0.28	0.56	0.75
	S. Deviation	0.35	0.33	0.30
	# of efficient firms	23.00	40.00	27.00
	% of efficient firms	0.17	0.29	0.20
Vertiente Noroccidental	mean	0.56	0.74	0.73
	median	0.46	0.94	0.82
	S. Deviation	0.37	0.30	0.31
	# of efficient firms	20.00	30.00	20.00
	% of efficient firms	0.32	0.48	0.32
Piedemonte Llanero	mean	0.58	0.66	0.83
	median	0.55	0.88	0.97
	S. Deviation	0.39	0.37	0.24
	# of efficient firms	35.00	42.00	36.00
	% of efficient firms	0.39	0.47	0.40

Table 3. Tobit Estimates

	Total Efficiency	Pure Efficiency	Scale Efficiency
% Displaced population in a municipality	0.104	0.082	0.151**
	(1.18)	(0.90)	(2.06)
Land reform beneficiaries dummy	0.008	-0.100	0.056
	(0.11)	(1.29)	(0.89)
Land reform beneficiaries in last 5 years	-0.227*	-0.202	-0.257**
	(1.68)	(1.46)	(2.29)
Area rented in	0.007**	0.004	0.015***
	(2.01)	(1.15)	(2.87)
Area rented out	-0.000	-0.000	-0.001
	(0.89)	(0.34)	(1.53)
Bought land during last 5 years	0.055	0.010	0.088*
	(0.99)	(0.17)	(1.93)
Sold land during last 5 years	-0.020	-0.065	0.039
	(0.24)	(0.75)	(0.56)
Land (log)	-0.007	-0.039***	0.021**
	(0.66)	(3.67)	(2.51)
Valles del Bajo Magdalena	-0.062	-0.111	-0.025
	(0.73)	(1.24)	(0.36)
Valles del Cesar and Ranchería	0.184**	0.173*	0.124*
	(2.06)	(1.83)	(1.68)
Magdalena Medio	0.074	0.063	0.048
	(0.80)	(0.64)	(0.62)
Magdalena Alto	-0.171**	-0.221***	-0.118*
	(2.16)	(2.65)	(1.78)
Vertiente Nororiental	0.175*	0.206**	0.119
	(1.90)	(2.06)	(1.57)
Altiplanos	0.040	0.026	0.091
	(0.45)	(0.27)	(1.21)
Vertiente Central	0.059	-0.066	0.096
	(0.69)	(0.75)	(1.37)
Vertiente Sur	-0.212***	-0.291***	-0.047
	(2.72)	(3.56)	(0.74)
Vertiente Noroccidental	-0.029	-0.086	0.015
	(0.30)	(0.85)	(0.19)
Piedemonte Llanero	0.040	-0.052	0.085
	(0.44)	(0.54)	(1.11)
Constant	0.625***	1.005***	0.672***
	(9.07)	(13.69)	(11.78)
Observations	925	925	925

Absolute value of t statistics in parentheses
Significant at 10%; ** significant at 5%; *** significant at 1%

Footnotes

1 The UAF is the area of land which, for given agroecological conditions, can generate income for a family. Because the UAF is defined at the level of municipalities and natural regions within these, it provides a better way of accounting for the potentially vast differences in land quality that are difficult to integrate into the analysis if only physical farm size is considered.

[2] Unidad de Producción Agraria. It is defined as the economic unit involved in agricultural and livestock production under a unique management. The UPA can have more than one plot as long the plots share the same "production means", i.e. same labor force, machinery and buildings, used for the purpose of agricultural production. Information is collected at the UPA level and at the plot level (whenever this is possible).

[3] These 11 regions are: (1) Valle del Sinú and San Jorge; (2) Valles del Bajo Magdalena; (3) Valles del Cesar and Ranchería; (4) Magdalena Medio; (5) Magdalena Alto; (6) Vertiente Nororiental; (7) Altiplanos; (8) Vertiente Central; (9) Vertiente Sur; (10) Vertiente Noroccidental; (11) Piedemonte Llanero.

[4] In the first stage 55 municipalities are selected as primary sampling unit (PSU) from a universe of 604 municipalities. The secondary sampling units (SSU) are 110 (2 for each PSU selected) and are constructed using the number of houses as a "proxy" for the number UPAs on the sampling unit. In the third stage 110 terciary sampling units, (UTM) or segments, are selected, one for each SSU. The segments are groups of UPAs (on average 16 UPAs per segment); all households and UPAs on the selected segments were interviewed.